

CHAPTER 1100 HIGHWAY TRAFFIC NOISE ABATEMENT

Topic 1101 - General Requirements

Index 1101.1 - Introduction

The abatement of highway traffic noise is a design consideration that is required by State and Federal Statutes and regulations and by Caltrans policy. This chapter provides design standards relating to the location, height and length of noise barriers and includes discussion on alternative designs, maintenance and emergency access considerations and aesthetics of noise barriers. Procedures and policies on minimum attenuation, design goals, assessing noise impacts, noise abatement criteria levels, priorities, reasonableness and feasibility, and cost-effectiveness are contained in the Project Development Procedures Manual and the Environmental Handbook.

1101.2 Objective

The objectives are: for new construction or reconstruction of highways, to limit the intrusion of highway noise into adjacent areas; on existing freeways to limit the noise intrusion to achievable levels within practical and financial limitations; and to limit the noise to the levels specified by statute for qualifying schools adjacent to freeways. To achieve these objectives the Department supports the following four approaches to alleviate traffic noise impacts:

- (1) *Reduction at the Source.* Reduction of traffic noise at the source is the most effective control. Therefore, Caltrans encourages and supports legislation to require reduction in motor vehicle noise as advances in the state-of-the-art of motor vehicle engineering permit.
- (2) *Encouraging Compatible Adjacent Land Use.* Caltrans encourages those who plan and develop land and local governments controlling development or planning land use near known highway locations to exercise their powers and responsibility to minimize the effect of highway vehicle noise

through appropriate land use control. For example, cities and counties have the power to control development by the adoption of land use plans and zoning, subdivision, building and housing regulations.

- (3) *Noise Abatement.* Caltrans will attempt to locate, design, construct, and operate State highways to minimize the intrusion of traffic noise into adjacent areas. When this is not possible, noise impacts may be attenuated by the construction of noise barriers.
- (4) *Noise Abatement by Others.* An increasing number of requests are being made to Caltrans by owners or developers to attenuate noise reaching adjacent properties for which the State's mitigation priority is low or nonexistent. The general policy is that all feasible steps must be taken in the design of the adjacent development to attenuate noise so as not to require encroachment on the State's right of way. The State shall assume NO review authority or responsibility of any kind for the structural integrity or the effectiveness of the sound attenuation of walls constructed by others outside of the State's right of way. Where it is determined to be necessary to permit others to construct a sound barrier within the State's right of way, the general policy is that the design will meet Caltrans geometric, structural, and safety standards as established in this and other manuals and that the effects of the barrier on operation, maintenance and aesthetics of the highway will be more beneficial than detrimental.

1101.3 Terminology

The terms "noise barrier" and "soundwall" are often used interchangeably. Technically, a "noise barrier" may be any feature which blocks, prevents or diminishes the transmission of noise. An earth berm could serve this purpose. A large building could serve as a noise barrier to shield receptors further from the noise source. A dense growth of vegetation, if it were wide enough and dense enough, would be a noise barrier. A "soundwall" is a particular type of noise barrier. It is a wall, which may be constructed of concrete panels, masonry blocks, wood boards or panels, or a variety of other materials.

1101.4 Procedures for Assessing Noise Impacts

Highway traffic noise impacts are identified in the project noise study report and are listed in the environmental document. The procedures for assessing noise impacts for new highway construction or reconstruction projects, retrofit projects (Community Noise Abatement Program - HB311) along existing freeways, and School Noise Abatement Projects (HB312), are included in Title 23, United States Code of Federal Regulations Part 772, the Environmental Handbook and Project Development Procedures Manual, and Section 216 of the Streets and Highways Code.

1101.5 Prioritizing Construction of Retrofit Noise Barriers

Legal requirements and procedures for prioritizing the construction of noise attenuation barriers are provided in Section 215.5 of the Streets and Highway Code and in the Caltrans Environmental Handbook.

Topic 1102 - Design Criteria

1102.1 General

This section covers the noise barrier location, various design aspects such as height and length of noise barriers, alternative designs, maintenance considerations, and aesthetic considerations. Various types of Caltrans standard noise barrier designs are referenced. Noise barrier design procedures, from the acoustical standpoint, are included in the Caltrans Environmental Handbook. Noise level criteria and guidelines on noise reduction can be found in Caltrans Environmental Handbook and Project Development Procedures Manual.

1102.2 Noise Barrier Location

(1) *Lateral Clearances.* **Minimum lateral clearance to noise barriers shall be as provided in Topic 309.1, Horizontal Clearances, of this manual, but shall not be less than 3 m.** Lateral clearances greater than the minimums should be used whenever feasible. Where terrain permits, the most desirable location for a noise barrier from a safety perspective is just

inside the right of way or, alternatively, 10 m or more from the traveled way.

When lateral clearance is 4.5 m or less, the noise barrier shall be placed on a safety shape concrete barrier. Guardrail or safety shape barrier protection should be considered when the noise barrier is located between 4.5 m and 9 m from the edge of the traveled way.

When the noise barrier is placed closer than 5 m from the traveled way, Traffic Operations should be consulted early in the design. Signs (overhead and ground mounted) and other poles and standards for lighting, Transportation Management items, call boxes, etc. should be detailed for mounting on the wall, incorporated into the wall foundation and possibly recessed into the surface of the wall.

- (2) *Sight Distance Requirements.* The stopping sight distance is of prime importance for noise barriers located on the edge of shoulder along the inside of a curve. Horizontal clearances which reduce the stopping sight distance should be avoided. Noise barriers within gore areas should begin or end at least 60 m from the theoretical curb nose location.
- (3) *Ultimate Location.* Noise barriers should be constructed at the ultimate location for the facility as discussed in the Project Development Procedures Manual.

1102.3 Noise Barrier Heights

- (1) *Minimum Height.* Noise barriers should have a minimum height of 1.8 m (measured from the top of the barrier to the top of the foundation).
- (2) *Maximum Height.* Noise barriers should not exceed 4.3 m in height (measured from the pavement surface at the face of the safety-shape barrier) when located 4.5 m or less from the edge of the traveled way, and should not exceed 5.0 m in height above the ground line when located more than 4.5 m from the traveled way.
- (3) *Truck Exhaust Intercept.* Current FHWA noise barrier design procedures result in noise barrier heights which often do not

intercept noise emitted from the exhaust stack of trucks. For design purposes, the noise barrier should intercept the line of sight from the exhaust stack of a truck to the receptor. The truck stack height is assumed to be 3.5 m above the pavement. The receptor is assumed to be 1.5 m above the ground and located 1.5 m from the living unit nearest the roadway. If this location is not representative of potential outdoor activities, then another appropriate location should be justified in the noise study report.

- (4) *Two-story Development.* The noise barrier should not be designed to shield the second story of two-story residences unless it provides attenuation for a substantial number of residences at a reasonable increase in cost. If the noise barrier is extended in height to provide second story attenuation, this attenuation is to be at least 5 decibels.
- (5) *Parallel Noise Barriers.* Frequently, noise barriers are constructed to shield noise receivers on both sides of a highway. These are referred to as parallel barriers. If the barrier surfaces are hard, relatively smooth, and non porous, such as concrete or masonry surfaces, the barriers can reflect noise back and forth between the barriers, decreasing their effectiveness. As a result of research performed by Caltrans and others, reflective parallel barriers should have a width-to-height ratio (W:H) of at least 10:1 to avoid a risk of perceptible reduction in performance of both noise barriers. The width is the distance between the two barriers, and the height is the average height of both barriers with reference to the roadway elevation. For example, two parallel barriers, one 3 m, the other 4 m high, should be separated by at least 35 m to avoid a noticeable degradation in performance. A perceptible, or noticeable decrease in performance is defined as a reduction of 3 dBA or more in barrier attenuation.

1102.4 Noise Barrier Length

- (1) *General.* Careful attention should be given to the length of a noise barrier to assure that it provides adequate attenuation for the end dwelling. The Caltrans Environmental Handbook provides guidance on

determining how far beyond the end dwelling a noise barrier should be extended. When appropriate, consideration should be given to terminating the noise barrier with a section of the barrier perpendicular to the freeway. This could reduce the overall barrier length, but may require an easement or acquisition from the property owner to permit construction of the noise barrier off the right of way.

- (2) *Gap Closures.* In some cases, short gaps may exist between areas qualifying for a noise barrier. The closure of these gaps should be considered on a project by project basis and be justified in the Project Report.
- (3) *Local Street Connections.* At on- and off-ramp connections to local streets, the Department's responsibility for noise abatement should be limited to areas where the traffic noise level from the State highway is the predominant noise source.
- (4) *Barrier Overlaps.* When the noise barrier has overlapping sections, such as when concealing an access opening, the walls must be overlapped a minimum of 2.5 to 3 times the offset distance in order to maintain the integrity of the sound attenuation.

1102.5 Alternative Noise Barrier Designs

- (1) *General.* Every noise barrier that is constructed as a part of new highway construction or reconstruction, or along freeways as a part of the Community and School Noise Abatement Programs, requires at least two alternative designs included in the contract plans. Selection of the most cost-effective and aesthetically pleasing designs should include an analysis of their life-cycle costs. The Project Development Procedures Manual discusses cost analysis of noise barriers.

Standard sheets for noise barriers (sound walls) developed by the Office of Structure Design have been furnished to the Districts. These standard designs include the following materials:

- Masonry block.
- Precast concrete panel (with post or mounted on safety shaped barrier).

- Wood (post and plank or framed plywood).
- Metal (ribbed steel).
- Composite beam (Styro-foam and wire mesh core with stucco exterior).
- Other design alternatives may be considered provided they meet the structural and noise attenuation criteria. Questions regarding the approval status of various designs or products should be directed to the Headquarters Noise Abatement Design Standards Engineer in the Office of Project Planning and Design.

Project Files for each noise barrier project should include the justification and background for the design type or the options allowed on each project.

(2) *Design Procedures.* The plans for alternative noise barriers are to be prepared using the standard sound wall sheets and the appropriate Standard Special Provisions. As a minimum, the sound wall plans are to show the horizontal alignment, the wall profile made up of a top elevation line and a bottom elevation line, the applicable standard sound wall detail sheets, and aesthetic features sheet. The top elevation line is defined as the profile line of the minimum wall height required for the design insertion loss, and the bottom elevation line is defined as the finished grade ground line. If a concrete safety-shape barrier is involved, the top of barrier is to be designated as the bottom elevation line of the sound wall. For alternative sound walls not on a barrier, the footing design does not have to be detailed on the plans. If a barrier is required, the pile layout should be detailed for only one of the alternative designs. Although this method does not require the detailing of one complete sound wall alternative, it does not remove the necessity to solve drainage, utility, foundation, or any other problems which are unique to each project.

(3) *Pay Quantities.* The pay item for alternative sound walls without a barrier is square meter of sound wall and is measured between the top elevation line and the

bottom elevation line. The square meter cost includes all types of supports (footings, piles and pile caps).

If the sound wall is on a barrier the sound wall pay item is measured from top elevation line to top of barrier, and the supporting piles or footings and barrier will be separate pay items.

The aesthetic features affect the amount of footing for the masonry block design, and these features must be shown clearly on the plans. The "Typical Sections" sheet is the recommended location to show the aesthetic treatment.

Refer to the Standard Special Provisions for more information on measurement and pay quantities.

(4) *Shop Plans.* The Special Provisions should require the successful bidder to submit two sets of shop plans of the selected alternate for approval. These shop drawings must show pile spacing, pile lengths, expansion joints location, and aesthetic treatment.

(5) *Preliminary Site Data.* In using the "Top Line/Bottom Line" concept, it is important that the preliminary site data be as complete as possible. To eliminate or minimize construction change orders the following guidelines are suggested.

- Provide accurate ground line profiles.
- Select only approved design alternative sound wall types.
- Provide adequate foundation investigation.
- Locate overhead and underground utilities.
- Review drainage and show any modifications on the plans.
- Determine and specify architectural treatment.
- Determine the need for special design, and coordinate with the Office of Structures Design during the early stages of design.

1102.6 Noise Barrier Aesthetics

- (1) *General.* A landscaped earth berm or a combination wall and berm tend to minimize the apparent noise barrier height and are probably the most aesthetically acceptable alternative, but unfortunately these alternatives are not suitable for many sites due to limited space.

Some moderate additional cost to enhance the noise barrier's aesthetic quality is usually warranted. However, elaborate or costly individualized designs which significantly increase the cost of the noise barrier should be avoided. Sound walls should not be designed with abrupt beginnings or ends. Generally, the ends of the sound wall should be tapered or stepped if the height of the sound wall exceeds 2 m. The District Landscape Architect should be consulted regarding the design of tapers or stepped ends, aesthetic treatment and landscaping for noise barriers.

- (2) *Standard Aesthetic Treatment.* Only the standard aesthetic treatments for the various alternative materials developed by the Division of Structures should be used. A description of the different types of aesthetic treatments developed are included in the "Instructions for Using the Standard Aesthetics Features Sheets" which are available from the Aesthetics and Models unit of the Division of Structures.
- (3) *Nonstandard Aesthetic Treatment.* When a nonstandard aesthetic treatment is proposed for noise barriers, the Headquarters Traffic Liaison should be consulted.
- (4) *Planting of Noise Barriers.* The use of plants in conjunction with noise barriers can help to combat graffiti and enhance public acceptance of the noise barrier. When landscaping is to be placed adjacent to the sound wall which will eventually screen a substantial portion of the wall, only a minimal aesthetic treatment is justified.

Index 902.3 of this manual and the Project Development Procedures Manual contain additional information on the planting of noise barriers.

1102.7 Maintenance Consideration in Noise Barrier Design

- (1) *General.* Noise barriers placed within the area between the shoulder and right of way line complicate the ongoing maintenance operations. When there is a substantial distance behind the noise barriers and in front of the right of way line, special consideration is required. If the adjoining land is occupied with streets, roads, parks, or other large parcels, an effort should be made during the right of way negotiations to have the abutting property owners maintain the area. In this case, the chain link fence at the right of way line would not be required. Maintenance by others may not be practical if a number of small individual properties abut the noise barrier.
- (2) *Access Requirements.* Access to the back side of the noise barrier must be provided if the area is to be maintained by Caltrans. In subdivided areas, access can be via local streets, when available. If access is not available via local streets, access gates or openings are essential at intervals along the noise barrier. Access may be provided via offsets in the barrier. Offset barriers must be overlapped a minimum of 2.5 to 3 times the offset distance in order to maintain the integrity of the sound attenuation of the main barrier. Location of the access openings must be coordinated with the District maintenance office.
- (3) *Noise Barrier Material.* The alternative materials selected for the noise barrier should be appropriate for the environment in which it is placed. For walls that are located at or near the edge of shoulder, the portion of the noise barrier located above the safety-shape concrete barrier should be capable of withstanding the force of an occasional vehicle which may ride up above the top of the safety barrier. At this location, concrete block, cast-in-place concrete, or precast concrete panels are the recommended alternative sound wall materials. In locations which are susceptible to fires, use of wood noise barriers should be avoided.

1102.8 Emergency Access Considerations in Noise Barrier Design

- (1) *General.* In addition to access gates being constructed in noise barriers to satisfy the Department's maintenance needs, they may also be constructed to provide a means to access the freeway in the event of a catastrophic event which makes the freeway impassable for emergency vehicles. These gates are not intended to be used as an alternate means of emergency access to adjacent neighborhoods. Access to those areas should be planned and provided for from local streets and roads. Small openings may also be provided in the noise barrier which would allow a fire hose to be passed through it. Local emergency response agencies should be contacted early in the design process to determine the need for emergency access gates and fire hose openings.
- (2) *Emergency Access Gate Requirements.* Access gates in noise barriers should be kept to a minimum and should be at least 300 m apart. Locations of access should be coordinated with the District Maintenance office. Only one opening should be provided at locations where there is a need for access openings to serve both the emergency response agency and Caltrans maintenance. Design of gates should comply with the soundwall details developed by the Office of Structures Design.
- (3) *Fire Hose Access Openings.* When there is no other means of providing fire protection to the freeway, small openings for fire hoses may be provided. Fire hose access should be located as close as possible to the fire hydrants on the local street system. Where possible, fire hose access should be combined with emergency or maintenance access openings. Design of fire hose openings should be requested from the Office of Structures Design.

1102.9 Drainage Openings in Noise Barrier

Drainage through noise barriers is sometimes required for various site conditions. Depending on the size and spacing, small, unshielded openings at ground level can be provided in the

barriers to allow drainage and not defeat the noise attenuation of the barrier. The following sizes of unshielded openings at ground level are allowed for this purpose:

- (a) Openings of 200 mm x 200 mm or smaller, if the openings are spaced at least 3 m on center.
- (b) Openings of 200 mm x 400 mm or smaller, if the openings are spaced at least 6 m on center, and the noise receiver is at least 3 m from the nearest opening.

The location and size of drainage openings need to be designed based on the hydraulics of the area. The designer should also take into consideration possible erosion problems that may occur at the drainage openings.

Where drainage requirements dictate openings that do not conform to the above limitations, shielding of the opening will be necessary to uphold the noise attenuation of the barrier. Shield design must consider the hydraulic characteristics of the site. When shields are determined to be necessary, consultation with the District Hydraulics Unit and the OPPD Coordinator and Noise Abatement staff is recommended.